

Amendments to the Specification

Please replace paragraph [0006] with the following rewritten paragraph:

Q1 [0006] It is a third ~~aspect-object~~ of the invention to provide a method of forming the hard multilayer coating having the technical advantage as described above. This third object may be achieved according to any one of sixth through eighth aspects of the invention which are described below.

Please replace paragraph [0037] with the following rewritten paragraph:

Q2 [0037] Fig. 2 is a view schematically showing, by way of example, an arc-type ion plating apparatus 30 which can be advantageously used for forming the hard multilayer coating 20. The arc-type ion plating apparatus 30 includes: a holding member 32 for holding a multiplicity of intermediate products in the form of the substrates 12 each of which is not yet coated with the hard multilayer coating 20 and has the peripheral and end cutting edges 16, 18 already formed therein; a rotary device 34 for rotating the holding member 32 about a rotation axis which extends substantially in a vertical direction; a bias-voltage power source 36 for applying a negative bias voltage to the substrates 12; a processing vessel in the form of a chamber 38 which accommodates therein the substrates 12; first and second arc-discharge power sources 44, 46; a reaction-gas supplying device 40 for supplying a reaction gas into the chamber 38; and a vacuum device 42 for sucking a gas in the interior of the ~~reactor 22~~ chamber 38 with, for example, a vacuum pump so as to reduce the pressure in the interior of the chamber 38. The holding member 32 consists of a cylindrical or prism member having a center at the above-described rotation axis. The multiplicity of substrates 12 are held by the holding member 32 such that each substrate 12 takes a substantially horizontal posture with the cutting teeth portion 14 protruding outwardly in a radial direction of the holding member 32. The reaction-gas supplying device 40 is equipped with tanks in which nitrogen gas (N<sub>2</sub>) and hydrocarbon gas (CH<sub>4</sub>, C<sub>2</sub>H<sub>2</sub>, etc.) are respectively stored. The reaction-gas supplying

device 40 is adapted to be activated in accordance with a desired composition of the coating layer. That is, the reaction-gas supplying device 40 supplies the nitrogen gas from the corresponding tank where the desired composition of the first coating layer 22 is TiAlN, while the device 40 supplies the nitrogen gas and the hydrocarbon gas from the respective tanks where the desired composition of the first coating layer 22 is TiAlCN. In the formation of the second coating layer 24 having the composition of mixture of CrN and  $(\text{Ti}_x \text{Al}_{1-x}) (\text{C}_y \text{N}_{1-y})$ , which is identical with  $(\text{Ti}_x \text{Al}_{1-x}) (\text{C}_y \text{N}_{1-y})$  of the first coating layer 22, CrN including nitrogen (N) is formed with the supply of the nitrogen gas.

[Please replace paragraph [0038] with the following rewritten paragraph.]

[0038] The first arc-discharge power source 44 is connected to an evaporation source in the form of a first cathode 48 which is formed of  $\text{Ti}_x \text{Al}_{1-x}$  (wherein  $0.20 \leq x \leq 0.60$ ) corresponding to the component of the first coating layer 22, and also to a first ~~cathode~~-anode 50. The first arc-discharge power source 44 serves to supply a predetermined amount of an arc current between the first cathode 48 and the first anode 50, for causing arc discharge therebetween, so that  $\text{Ti}_x \text{Al}_{1-x}$  is evaporated from the first cathode 48. The evaporated  $\text{Ti}_x \text{Al}_{1-x}$  becomes metallic ions (positive ions), and then adheres to the substrates 12 to which the negative bias voltage is applied by the bias-voltage power source 36. Similarly, the second arc-discharge power source 46 is connected to another evaporation source in the form of a second cathode 52 which is formed of Cr corresponding to the component of the second coating layer 24, and also to a second ~~cathode~~-anode 54. The second arc-discharge power source 46 serves to supply a predetermined amount of an arc current between the second cathode 52 and the second anode 54, for causing arc discharge therebetween, so that Cr is evaporated from the second cathode 52. The evaporated Cr becomes metallic ions (positive ions), and then adheres to the substrates 12 to which the negative bias voltage is applied by the bias-voltage power source 36. The first and second cathodes 48 and 52 are positioned in

their respective positions which are symmetrical with each other with respect to the holding member 32 as viewed in substantially a horizontal direction.

[Please replace paragraph [0039] with the following rewritten paragraph:]

[0039] Fig. 3 is a flow chart illustrating a procedure for forming the hard multilayer coating 20 on a surface of the cutting teeth portion 14 of the substrate 12, by using the arc-type ion plating apparatus 30. Prior to the implementations of steps S1-S3, the pressure in the interior of the chamber 38 is held in a predetermined value (which ranges, for example, from  $1.33 \times 5 \times 10^{-1}$  Pa to  $1.33 \times 40 \times 10^{-1}$  Pa) by the reaction-gas supplying device 40 and the vacuum device 42, while a predetermined value of the negative bias voltage (which ranges, for example, from -50V to -150V) is applied to the substrates 12 by the bias-voltage power source 36. In this instance, the vacuum device 42 vacuums the ~~chamber 30~~ chamber 38, and at the same time the reaction-gas supplying device 40 supplies the reaction gas into the ~~chamber 30~~ chamber 38 in such a manner that holds the pressure in the interior of the ~~chamber 30~~ chamber 38 in the above-described predetermined value. The steps S1-S3 are then implemented with the rotary device 34 being activated to rotate the holding member 32 at a predetermined number of revolutions (for example,  $3 \text{ min}^{-1}$ ), so that the hard multilayer coating 20 is formed on the substrate 12. Such a formation of the hard multilayer coating 20 is carried out under control of a control device including a computer.

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Please replace paragraph [0041] with the following rewritten paragraph:

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0<sup>3</sup> [0041] The step S1 is followed by the step S2, in which the first arc-discharge power source 44 is held on so as to supply the arc current of about 145A between the first cathode 48 and the first anode 50 for about 0.4 minutes (24 seconds) for thereby causing arc discharge therebetween, while at the same time the second arc-discharge power source 46 is held on so as to supply the arc current of about 120A between the second cathode 52 and the second anode 54 for the same period (about 0.4 minutes) for thereby causing arc discharge

therebetween, so that the second coating layer 24 consisting of the mixture of  $(\text{Ti}_x \text{Al}_{1-x}) (\text{C}_y \text{N}_{1-y})$  and CrN and having a predetermined thickness is formed on the first coating layer 22 which has been formed as described above. The values of the arc currents supplied by the respective first and second arc-discharge power sources 44, 46 are determined based on the desired proportions of  $(\text{Ti}_x \text{Al}_{1-x}) (\text{C}_y \text{N}_{1-y})$  and CrN and the desired thickness of the second coating layer 24. The power-on times of the first and second arc-discharge power sources 46 44, 46 are determined based on the desired thickness of the second coating layer 24. Under this condition, it is possible to form a coating layer consisting of the mixture of  $\text{Ti}_{0.4} \text{Al}_{0.6} \text{N}$  and CrN and having a thickness of about 20nm as “CrN mixture layer” (which represents the second coating layer 24) of Sample No. 10 shown in the table of Fig. 4. In the present embodiment, since the substrate 12 as the intermediate product is rotated about the above-described rotation axis which extends substantially in the vertical direction,  $\text{Ti}_{0.4} \text{Al}_{0.6} \text{N}$  and CrN adhere to the substrate 12 in an alternated and repeated manner while being partially mixed with each other.

[Please replace paragraph [0042] with the following rewritten paragraph:]

[0042] The above-described steps S1 and S2 are implemented by a predetermined number (n-1) of times, wherein the predetermined number is smaller than the total number (n) of the first and second coating layers 22, 24 by one (1). After the predetermined number (n-1) of times of implementations of the steps S1, S2, the step S3 is implemented to ~~from~~form the first coating layer 22 as the outermost layer. For example, in the case of the Sample No. 10 in the table of Fig. 4 in which the total number of the first and second coating layers 22, 24 is fifteen, the steps S1 and S2 are alternately implemented fourteen times, for thereby alternately forming the first and second coating layers 22, 24. After the formations of the seven first coating layers 22 having the respective thicknesses equal to each other and the seven second coating layers 24 having the respective thicknesses equal to each other, the step S3 is

implemented. In the step S3, the time for the formation of the first coating layer 22, i.e., the power-on time for which the first arc-discharge power source 44 is held on is longer than in the step S1 by a predetermined time  $\alpha$ , by which the thickness of the first coating layer 22 formed in the step S3 is larger than that of the first coating layer 22 formed in the step S1. Thus, the implementation of the step S3 provides, as the outermost layer, the first coating layer 22 having excellent heat resistance and wear resistance. It is noted that, in the column of "Thickness (nm)" of " $(\text{Ti}_x \text{Al}_{1-x}) (\text{C}_y \text{N}_{1-y})$  layer" in the table of Fig. 4, the value indicated on the right side of "/" (slash) represents the thickness of the first coating layer 22 as the outermost layer, while the value indicated on the left side of "/" (slash) represents the thickness of the first coating layer 22 as the layer other than the outermost layer.

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